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SPECIFICATION

Title of the Invention

Starting Device for Methanol Fuel Cell

Claims

A starting device for a methanol fuel cell, wherein

a liquid fuel cell having a means for supplying fuel to a fuel electrode-side chamber having an electrolyte solution inside and a fuel electrode on a side surface and a means for supplying air or oxygen to an air electrode-side chamber that is partitioned from said fuel electrode-side chamber via a separating membrane, has an air electrode on a side surface, and contains electrolyte solution inside [so that the air or oxygen is supplied] to said air electrode surface,

a by-pass means that supplies air or oxygen directly to said fuel electrode surface is provided, and, during initial operation of the cell, air or oxygen is supplied for a determinate period of time along with the fuel to said fuel electrode surface via said bypass means.

Detailed Description of the Invention

The present invention relates to a starting device for methanol fuel cells used as, for example, power sources for powering electric automobiles or the like.

Fuel cells that bring about electrochemical reactions between a fuel and oxygen in order to obtain electrical energy have extremely low heat loss. In principle, when these cells are used in combination with electric motors, automobiles can be realized that have extremely favorable energy efficiency in comparison to common internal combustion engines.

In terms of fuel cells, carbon-oxygen fuel cells that are used in aerospace devices and the like have already been realized. However, when the attempt is made to use these cells as-is in electric automobiles, it is difficult to use hydrogen fuel which is an extremely combustible gas, regardless of the storage or loading methods. The practicality of such cells is thus extremely limited.

Consequently, fuel cells that employ methanol in liquid form have been receiving attention, and a methanol fuel cell that achieves dramatic performance improvements has previously been offered by the applicant of this application.

Moreover, methanol can be conceivably produced by the liquefaction of coal, and thus methanol fuel cells hold much promise as a substitute for petroleum energy.

However, with fuel cells of the type that use liquids such as methanol, the temperature of the cell unit must be maintained at about 60°C in order to achieve the desired electrochemical reaction between the fuel and air.

For this reason, during start-up of the fuel cell, and specifically at initiation of operation, the cell is warmed up using joule heat obtained by utilizing electrolyte resistance or heat generated at the electrode plates, thereby increasing the temperature of the cell unit to the optimal operating temperature.

However, it is not possible to rapidly warm the cell unit with these types of conventional heating devices, and there is the disadvantage that time is required for warm-up.

Moreover, there is also the problem that the fuel electrode is not effectively heated, which is absolutely necessary in order to maintain optimal temperatures.

The present invention was developed in light of this state of affairs, and has the objective of providing a liquid fuel cell starting device whereby, during startup of fuel cell operation, air is introduced into the fuel cell chamber together with the fuel, the fuel is catalytically combusted at

the fuel electrode, and this heat is utilized in order to heat the fuel electrode of the cell. This results, specifically, in effectively increasing the fuel electrode temperature in a short period of time, thereby reducing the warm-up time.

The present invention is described in reference to the figures below by providing working examples in which present invention is employed in a methanol fuel cell.

In the figure, **1** denotes a fuel cell main unit consisting of a fuel electrode **2**, an air electrode **3**, a fuel cell **4** and an air chamber **5**.

The fuel electrode **2** and air electrode **3** are produced by applying platinum-based alloy to the surface of a side of the fuel chamber supports **6**, **7** composed of conductive porous material (e.g., graphite). The fuel electrode **2** thus also serves as a fuel oxidation catalyst.

Lead wires **8** and **9** are connected to the supports **6** and **7**, and electrical energy is taken off via these lead wires **8** and **9**.

On the other hand, 5 to 30% sulfuric acid aqueous solution used as electrolyte fills the fuel chamber **4** that is sandwiched by the air electrode **3** and fuel electrode **2**, leaving a specified gap. The fuel chamber **4** is further partitioned into a fuel electrode-side chamber **11** and air electrode-side chamber **12** by means of an acid-resistant separation membrane **10**.

Fuel methanol enters into the electrolyte, but the methanol from the fuel tank **14** is conveyed under pressure by means of a fuel supply pump **15** into the electrolyte via a fuel pathway **13** that connects with the fuel electrode-side chamber **11**.

The separation membrane **10** has characteristics whereby it prevents methanol alone from passing through it, and thus ingress of methanol from the fuel electrode-side chamber **11** to the air electrode-side chamber **12** is prevented. By means of this action, it is possible to prevent inhibition of the function of the air electrode **3**.

In addition, a configuration is produced in which air (oxygen) is supplied from a blower **17** via the air pathway **16** to the air chamber **5** that is adjacent to the air electrode-side chamber **12**, separated by the support **7**. The air pathway **16** is connected with the fuel pathway **13** downstream from the pump **15** via a bypass pathway **18**, and a bypass valve **19** is interposed along this pathway.

With the fuel cell configured in this manner, the water and methanol in the electrolyte undergo a reaction of the type indicated in the formula below at the fuel electrode **2**.

$$CH_3OH + H_2O \rightarrow CO_2\ 6H^+ = 6e^- \qquad (1)$$

At the air electrode **3**, on the other hand, the hydrogen ions in the electrolyte, the oxygen from the air chamber **5** that has passed through the support **7** and has dissolved in the electrolyte, and the electrons generated at the fuel electrode **2** undergo a reaction of the type indicated in the formula below.

$$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$$

The electrons that are generated at the fuel electrode **2** and consumed at the air electrode **3** supply electric energy.

As is clear from formulas (1) and (2), the carbon dioxide gas and water that are generated at the fuel electrode **2** and air electrode **3** respectively are discharged externally from the cell unit **1** as gases from the inlets **20** and **21** provided at the top of the fuel electrode-side chamber **11** and air electrode-side chamber **12**.

However, considering the boiling point of methanol, in order to effectively bring about the reactions of formulas (1) and (2), it is necessary to maintain the surface temperature of the fuel electrode 2, in particular, at about 50 to 70°C. Consequently by rapidly heating the fuel electrode **2** when cell operation is initiated, the desired electrical energy can be ensured in a short time period.

Thus, when initiating cell operation in the present invention, the fuel supply pump **15** is first operated, and, along therewith, the bypass valve **19** is opened, and methanol and air are supplied to the fuel electrode-side chamber **11**.

The methanol and air undergo catalytic combustion at the surface of the fuel electrode **2**, and this heat rapidly heats the surface of the fuel electrode **2**.

As a result, it is possible to rapidly increase the surface temperature of the fuel electrode **2** to a range in which favorable operation occurs. Thus, the time period required for obtaining sufficient electrical energy can be dramatically decreased relative to the prior art when operation of the cell is initiated, specifically, during start-up.

After heating the surface of the fuel electrode **2** to the prescribed temperature range in this manner, the bypass valve **19** is closed, thereby stopping air supply. Methanol alone is thereby supplied to the fuel electrode-side chamber **11**.

In this case, the surface of the fuel electrode **2** that has been heated to the prescribed temperature range is then warmed by the joule heat to some extent that is generated during production of electricity, and the surface is thus continually maintained at the prescribed temperature range.

A working example has been described in which the invention was employed in a methanol fuel cell, but the present invention can be similarly utilized in other liquid fuel cells.

As described above, in the present invention, an air (oxygen) bypass means is provided, so that air (oxygen) is introduced into the fuel electrode-side chamber in addition to fuel during initiation of cell operation. As a result, catalytic combustion of fuel occurs at the fuel electrode. The surface of the fuel electrode is thus rapidly heated to the desired operation range, and the warm-up time required to obtain sufficient electric energy at the beginning of operation is greatly decreased relative to the prior art.

Consequently, when the present invention is used in fuel cells for electric automobiles, it is possible to produce an electric automobile that has far superior start-up characteristics.

Brief Description of the Drawings

The drawing is a schematic sectional view showing a working example of the present invention.

1	Fuel cell unit
2	Fuel electrode
3	Air electrode
4	Fuel chamber
5	Air chamber
10	Separating membrane
11	Fuel electrode-side chamber
12	Air electrode-side chamber
13	Fuel pathway
14	Fuel tank
15	Fuel supply pump
16	Air pathway

17 Blower

18 Bypass pathway

19 Bypass valve

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